

representing the facts at the time, they go far toward explaining one of the greatest difficulties against the acceptance of the hypothesis that the waters by which the plains were flooded were in communication with those of the sea. The difficulty alluded to is the complete absence, so far as yet ascertained, of the remains of marine organisms from the glacial deposits. While prolonged weathering and the action of sub-aërial waters might result in the removal of calcareous organic remains from certain parts of these deposits, the condition of much of the boulder-clay, together with the occasional actual occurrences in it of fragments of Cretaceous or Laramie shells, is such as to show that any contemporaneous mollusks might have been preserved. If, however, the body of water in question, though communicating with the sea to the northward, was almost throughout closed to the south and in receipt of large quantities of fluvial water, it may well have been in great part brackish, if not almost entirely fresh. Adding to this the conception of its frigid temperature due to the great abundance of ice with which it must have been laden, and the vast amount of fine sediment which must have been carried into it by sub-glacier streams, it will be apparent that the conditions were singularly inimical to the existence of life of any kind, whether that characteristic of salt or fresh water. Somewhat similar conditions, though on a much smaller scale and without the adjunct of glacial waters or glaciers, occur in the southern extremity of Hudson Bay, where, as Mr. A. P. Low informs me, marine life is almost entirely absent, the water being nearly fresh and clouded with mud derived from the large entering rivers and from the action of the waves upon the shallow earthy shores."

Finally the climatal conditions deducible from the geological facts coincide with these facts in enforcing the probability that the great ice age of North America depended mainly on the existence of high mountains, surrounded by submerged areas, traversed by ice-laden currents, and that we are to imagine, not a continent covered with ice, but a submerged continent, with snow-clad mountains rising at its margins, and forming the gathering grounds of great local glaciers—the *Cordilleran*, the *Laurentide*, and probably the *Appalachian* glaciers. These were the favouring conditions, but the author does not venture to deny the co-operation of other and cosmical causes. He concludes as follows:—

"When the study of the superficial deposits of different parts of Europe and America was for the first time seriously begun, it was endeavoured to explain the phenomena entirely by diluvial action, and when the evidence of ice-action became insuperable, icebergs and floating ice only were at first admitted as factors. Since that time the pendulum of opinion appears to have swung to the opposite extreme, and the energies of the majority of investigators have been extended in endeavouring to account for the varied facts of what has become definitely known as the Glacial period, almost exclusively by the action of great confluent glaciers. From this extreme point, the pendulum may now be supposed to have returned so far, as to leave the hypothetical North Polar ice-cap almost without an advocate, but at what position it may eventually come to rest time alone can decide. I am aware that some of those who have accepted what I may perhaps be pardoned for characterizing as extreme views as to glacier action, have more or less completely, and to their own satisfaction at least, solved all difficulties opposed to the action of land ice, such as those presented by the facts met with over the Great Plains, by the application to these of their single universal menstruum. For myself I need only say that I have endeavoured to approach the subject of the glaciation of the north-western part of the continent, here reviewed, untrammelled by *a priori* theories, and with some personal familiarity in the field with nearly all parts of the region dealt with."

The above is only a hurried and imperfect summary. The paper itself, as containing the matured conclusions of long and thorough investigation by an able and earnest explorer, should be carefully read by all interested in the structure of the Great Cordilleran backbone of the American continent.

THE SCIENTIFIC INVESTIGATIONS OF THE FISHERY BOARD FOR SCOTLAND.¹

THE results of the scientific investigations for 1889 are given in full detail with numerous tables and two charts. It was found that, during the year, no increase but rather a decrease,

¹ "Eighth Annual Report of the Fishery Board for Scotland." Part III. Scientific Investigations.

mainly in the migratory round fishes, occurred in the closed waters, and likewise in the open waters adjacent, the results of 1887 having been proved exceptional. The results of concurrent investigations carried on on board the *Garland* into the food of fishes, their spawning, and the distribution of the young, show that great and important differences—which must be taken into consideration both from a scientific and legislative point of view—prevail among the various food-fishes (Section A).

Dr. Wemyss Fulton, in his paper on the distribution of immature sea-fish and their capture by various modes of fishing, gives the results of the investigations into this important subject. The fundamental question as to what an immature fish is, has been determined for the first time by the examination and measurement of 13,000 fishes. The maximum size (as given in detailed tables) varies very much according to the species; any law regulating the legal sale of fish on the principle of size is therefore not based on scientific data. The distribution differs in the same way, but territorial waters serve as nurseries for the young fish. Tables given show the distribution of immature fishes at distances from the shore up to 22 miles and in various depths of water. Details are also given as to the proportion of immature food-fishes captured by the various modes of fishing. Dealing practically with the wasteful destruction of immature food-fishes, Dr. Fulton points out the difficulty of deciding among the different species, and shows how difficult it will be to save immature fish from capture and destruction by the beam-trawl, as that engine is now employed. The recommendations briefly are: that an inquiry should be made as to the retention of vitality by the various kinds of immature fish brought up in the trawl in order to ascertain the chances of survival if replaced in the sea; the protection of nurseries whose areas are capable of definition; the preservation of flat-fish under a certain size; and the establishment of hatcheries for sea-fish. A simple method is explained by which fishermen and trawlers might add to the fish-supply by fertilizing the ova of ripe fish when captured.

Regarding this Report, it should be noted that the importance of this question is not a thing which has dawned upon the Scottish Fishery Board since the conduct of scientific investigations was placed under new management (that of Dr. Fulton). In this paper, as in many others—indeed, everywhere in this year's Report—the willingness to ignore all that was done during the years that Prof. Ewart was convener of the Scientific Committee is very evident. In the Report of 1887 it is stated that "We have organized a series of extensive and systematic inquiries into the conditions of the reproductive organs of various kinds of fishes throughout the entire year, with particulars as to their size, &c., which will help to clear up the hitherto obscure problems as to the minimum size of sexually mature individuals, &c." We have certain information that the original discoveries which led to this Report on immature fish were made by one who has done more than his share to redeem the work of the Fishery Board. And it is only fair that the credit which is Mr. T. Scott's due, and which is denied him there should be acknowledged here.

Dr. Fullarton furnishes a Report, with chart, on the cockle-beds of Barra (in the Hebrides), which furnishes the chief cockle-fishing in Scotland. It is desirable—and the wish of the fishermen themselves—that means should be taken to prevent the taking of undersized cockles, and to insure the working of the beds in rotation.

Dr. Fullarton also gives a paper on oyster-culture fauna in France and Holland. It is most desirable that scientific and practical measures should be taken to revive the Scotch oyster-fishing, which has gradually declined, and these should be planned on known and tried lines. The same must be said of the cultivation of mussels, and this should be urged even more strongly, as their scarcity or abundance are of the utmost importance to the line-fishermen. Lobsters also call for practical legislation and artificial cultivation. The Fishery Board are constructing a lobster inclosure at Brodwick, Arran, and hope that means will be provided for their carrying on operations at the recently established hatchery at Dunbar.

Section B contains the biological investigations. The food of fishes was dealt with in an elaborate Report by Mr. Ramsay Smith, based upon the examination of many thousand food-fishes which prove to live chiefly upon Crustacea, Annelids, Echinoderms, Mollusks, and upon one another. There are great differences, however, as to the proportion of the organisms selected as food by different fishes, and the proportions of the

dietary vary to some extent at different places and at different seasons. These observations will ultimately demonstrate what organisms are valuable as fish-foods and what are not; the proportion in which the various vertebrates compose the dietary of fishes; and the possibility of introducing a valuable food-fish, such as the English sole, in places where it is absent or scarce. They will also show in what way the organisms forming the food of fishes may be protected and improved.

In a Report on the spawning and spawning-places of food-fishes, Dr. Fulton describes the results of the observations made during the year, many thousands of fishes having been examined on board the *Garland* all along the coast, and the duration of their spawning period in most instances determined. The duration of the spawning period varies much in different fish, and in some cases fully-grown adults appear not to spawn every year. The majority of the food-fishes congregate at the spawning time in immense shoals on the east coast at grounds lying from about eight to above twenty miles from shore in what may be termed the extra-territorial spawning zone. The young fishes are not, as a rule, found at the place of spawning, the floating pelagic eggs being carried by the currents chiefly shorewards. Dr. Fulton gives reasons for the belief that the selection of a particular offshore ground for spawning depends upon the set of the surface currents at the spawning season, these carrying the floating eggs during their development to the zones where food for the young fishes is abundant and shelter most readily secured.

Prof. W. C. McIntosh has made an elaborate study of the pelagic fauna of St. Andrews Bay, of which the second part, dealing with the distribution of the invertebrate organisms which form the food of many larval and other fishes, is now given.

Prof. McIntosh has also, in another paper, described the ova of the food-fishes and the larval and post-larval stages obtained in the *Garland's* tow-nets at various parts of the coast. These include the ova or larvæ of plaice, lemon-sole, flounders, dabs, cod, haddocks, ling, whiting, &c., and they constitute an indispensable part of the general study of the reproduction of the food-fishes.

Mr. Thomas Scott, in his valuable additions to the fauna of the Firth of Forth, gives a list of 80 species of organisms, not previously recognized as belonging to that locality. Some of these are for the first time recorded from the east of Scotland; some are new to Britain, and a few new to science. This paper is illustrated by two plates.

Mr. Scott, in his Report on the invertebrate fauna of inland waters, gives the result of the first investigations into the invertebrate organisms present in Scottish lochs and inland waters ever carried on in this country.

Dr. Fullerton's paper on the development of the clam is one which would hardly have found acceptance in any scientific journal. Had text and plates been submitted to the judgment of a skilled investigator, there would have been little or nothing of either for publication, as both display gross inaccuracy. There are many very remarkable statements in this paper, and the author naïvely describes as normal, phenomena whose pathological nature the merest tyro ought to be able to recognize.

Dr. John Beard, in his paper (illustrated by three plates) on the development of the common skate, gives the result of the study of this subject, on which very little has been written, though the skate is one of the most common elasmobranch fishes of our seas. The development of the embryo as it lies within its "purse" at the bottom of the seas occupies probably nine or ten months, being more rapid in summer than in winter. The eggs may be deposited throughout the year, but chiefly in March and April. Dr. Beard furnishes minute descriptions of the egg-cases or "purses" of the various species of skates and rays, and of the various stages in the development of the embryo. He discusses the function of the temporary external gills, so characteristic in advanced stages of development; and, in opposition to other authorities, he gives good reason for the belief that they are purely respiratory in function, and are adapted to the special conditions under which the developing embryo is placed.

Dr. Fulton, in his paper on the proportional numbers and sizes of the sexes among sea-fishes, gives the results of his inquiries, based upon the examination of 12,666 fishes. Females are, as a rule, more numerous than males; the female is also as a rule larger, but the male is the larger among the cod, haddock, and a few other fishes.

Among the "Notes and Memoranda" will be found Mr. Scott's hybridism among fish, the account of ingenious and in-

teresting experiments made on board the *Garland* on the artificial fertilizing of the ova of certain species of sea-fishes with the milt of other species sometimes widely separated zoologically. Dr. Fulton sends interesting notes on the reproduction and migrations of the common eel, and on the presence of anchovies in Scotch waters. Regarding the former paper, it should be remembered that a German zoologist recently obtained a conger-eel at Zanzibar with eggs ten times the size of those here described. There is nothing really remarkable in the reproductive organs of the eel obtained at Howietoun, eels with eggs as large being very often caught. It has usually been estimated that the eel produces five millions of ova. The number is here increased to upwards of ten millions, and the method by which this was counted is not given. There is a lamentable looseness in quoting literature, even that of British zoology. We are told that *Myxine* is a protandric hermaphrodite, and that this was discovered by Nansen. As a matter of fact, the discovery was made by a Scotch naturalist (Cunningham), and within a short distance of Edinburgh. If Nansen's paper had been read as well as quoted, this misstatement would not have been made.

Section C contains notes on contemporary work relating to fisheries in this and other countries. We note that no mention is made, however, of the very important "Plankton" expedition of Germany of last year, which is the more to be wondered at as interesting accounts of the expedition have been published in Germany.

It is much to be regretted that the Fishery Board Bill of last year did not become law. The conduct of scientific investigations might then have been placed in different hands, with the result, among other things, that properly-organized scientific work would have been carried on by a thoroughly competent scientific staff, and the Government grant of £2000 a year usefully and judiciously expended, instead of being, as at present, frittered away because the dominant clique of the Fishery Board do not know what to do with it. The Scientific Department of the Fishery Board needs reorganization quite as much as the Fishery Board itself. Under the control and direction of the leading Scottish biologists, some adequate return ought to be made for the nation's money. To do this, however, the work must be properly planned and directed, and moreover the working of the different investigations given only to men who really understand their subject. Government has been asked, and is asked in the present Report, to furnish increased funds. We hope and believe that the authorities will be wise enough to stay their hand till they can reorganize everything connected with the Fishery Board.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Love, St. John's, and Mr. Coates, Queens', have been appointed Moderators, and Mr. Wallis, Corpus, and Mr. Burnside, Pembroke, Examiners for the next Mathematical Tripos, Part I.

Mr. L. Fletcher, Keeper of Minerals at the British Museum, and Mr. H. P. Gurney, of Clare College, are nominated Examiners in Mineralogy for the Natural Sciences Tripos.

Mr. H. M. Stanley was, on October 23, admitted to the honorary degree of LL.D.

The following communications were made to the Cambridge Philosophical Society at the annual general meeting on October 27:—The President, the origin and early years of the Society; Mr. C. Chree, on the vibrations of some simple systems; Dr. A. Gamgee, on the principle on which Fahrenheit constructed his thermometrical scale; Mr. H. J. Sharpe, on liquid jets.

The Harkness Scholarship for Women, tenable at either Girton College or Newnham College, Cambridge, is to be awarded triennially to the best candidate in an examination in geology and palæontology, provided that sufficient proficiency is shown. The candidates must be resident members of Girton or Newnham College, in their first or second term. The Scholarship will be of the value of about £35 a year for three years. The next award will be made in 1891. The examination will be held at Cambridge in the Michaelmas Term, and the award will be made on or before November 15, 1891. The intended range of examination is indicated by the following schedule:—General physical geography; such geological phenomena as are matters of common observation; the principal agencies which change or modify the earth's surface and the life on it; outlines